Building Structures with a Swarm of Robots

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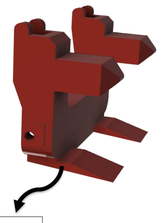
Background: Robot Construction

- Advances in construction automation have primarily focused on creating large complex machines
- Our approach focuses on using a team of small and simple robots to build complex structures
- Instead of using complex robot manipulators and simple building materials, we embed most of the complexity in the build modules
- Our method is scalable and portable

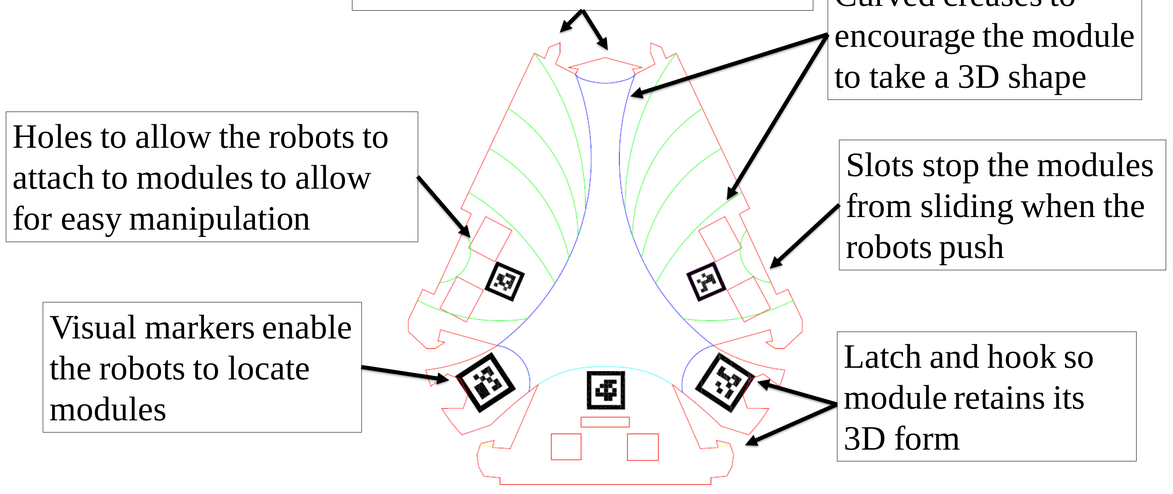
Experiment Design

- 4 Cozmo robots were used for our research project because of their size and vision capability
- For our proof-of-concept, modules were laser cut from cardstock

- Our 3D printed forklift attachments enable the Cozmos robots to manipulate cardstock modules

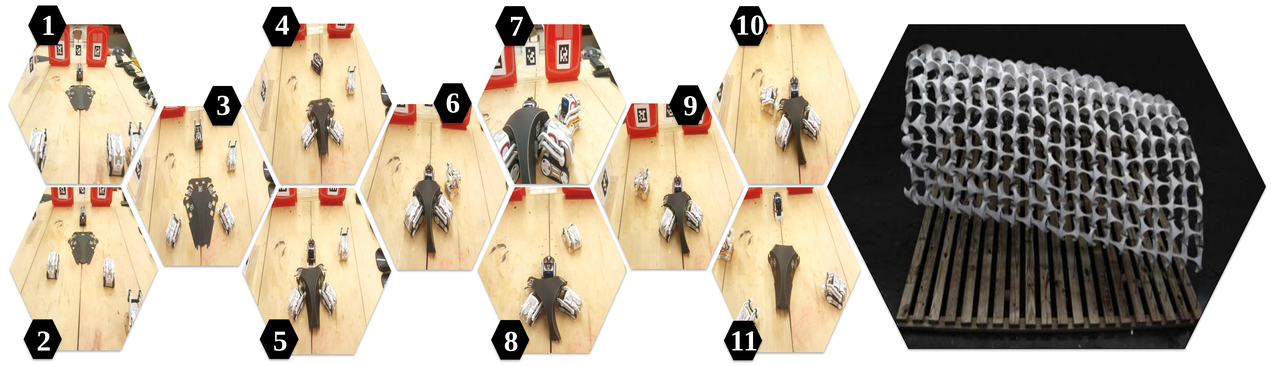


Attachments snap on and off the Cozmo robot's lift



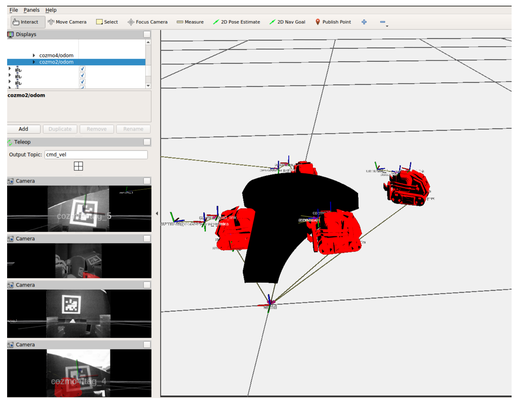
- The Robotics Operating System (ROS) was used to show a visual display of each robot and the pose data of it's joints and links.
- The robots communicate with each other via ROS

Results: Robot Team Folds 3D bricks



4 robots build a 3D module in 11 steps

We built a 5 foot tall art piece to illustrate the type of structures that can be built with cardstock modules



Built-in latches enable the module to retain a rigid 3D form

Conclusion

- The building of complex structures with low dexterity robots working together is feasible
- By embedding complexity into 2D modules interesting 3D modules can be formed depending on where the creases have been cut

Conference Publication

Designing for Digital Assembly with a Construction Team of Mobile Robots – ACADIA 2018

Future Work

- Link bricks into a 2D mesh
- Catalogue folding operations robot teams can perform
- Optimize module shapes and latching methods to create more robust structures
- Exploit pop-up book construction methods for quick assembly